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INTERNATIONAL PRELIMINARY EXAMINATION REPORT (PCT Article 36 and Rule 70)

Applicant's or agent's file reference 99 964 a/ubr	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/PEA/416)	
International application No. PCT/EP2003/014788	International filing date (<i>day/month/year</i>) 23.12.2003	Priority date (<i>day/month/year</i>) 23.12.2003
International Patent Classification (IPC) or both national classification and IPC H04L12/56		
Applicant TELEFONAKTIEBOLAGET L M ERICSSON (PUBL) et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 5 sheets, including this cover sheet.
- ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).
- These annexes consist of a total of 9 sheets.

3. This report contains indications relating to the following items:
- I ☒ Basis of the opinion
 - II ☐ Priority
 - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
 - IV ☐ Lack of unity of invention
 - V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
 - VI ☐ Certain documents cited
 - VII ☐ Certain defects in the international application
 - VIII ☐ Certain observations on the international application

Date of submission of the demand 18.07.2005	Date of completion of this report 20.02.2006
Name and mailing address of the international preliminary examining authority:  European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016	Authorized Officer Lamadie, S Telephone No. +31 70 340-4477 

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. **PCT/EP2003/014788**

I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

Description, Pages

1-20 as originally filed

Claims, Numbers

1-32 received on 05.12.2005 with letter of 05.12.2005

Drawings, Sheets

1/4-4/4 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
☐ the language of publication of the international application (under Rule 48.3(b)).
☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
☐ filed together with the international application in computer readable form.
☐ furnished subsequently to this Authority in written form.
☐ furnished subsequently to this Authority in computer readable form.
☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

**INTERNATIONAL PRELIMINARY
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5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	1-32
	No: Claims	
Inventive step (IS)	Yes: Claims	1-32
	No: Claims	
Industrial applicability (IA)	Yes: Claims	1-32
	No: Claims	

2. Citations and explanations

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

The term "flow control parameter" being vague (see point VIII), the following reasoning is based on the assumption that the "flow control parameter" is a parameter introduced by one of a sender or a receiver and being part of a predetermined flow control procedure (see description page 3 lines 6 to 31 and page 7 lines 6 to 9).

Reference is made to the following document:

D1: EP-A-1 249 972 (ERICSSON TELEFON AB L M) 16 October 2002 (2002-10-16)

1. The document D1 is regarded as being the closest prior art to the subject-matter of claim 1, and shows (the references in parentheses applying to this document) a method of controlling a queue buffer, said queue buffer being connected to a link and being arranged to queue data units of a flow in a queue (page 8 lines 29 to 36), comprising
determining a value of a length parameter related to the length of said queue (figure 2),
comparing said value with a length threshold value and performing a congestion notification procedure if said value is greater than said length threshold value, and
an automatic threshold adaptation procedure,
characterized in that said automatic threshold adaptation procedure comprises a procedure for adjusting said length threshold value on the basis of one or more link characteristics (page 4 lines 1 to 10).

The subject-matter of claim 1 differs from this known D1 in that the automatic threshold adaptation procedure comprises a procedure for adjusting said length threshold value on the basis of one or more **flow control parameters**.

The subject-matter of claim 1 is therefore new (Article 33(2) PCT).

The problem to be solved by the present invention may be regarded as how to integrate the buffer management actions with flow control decisions, and avoid the situation where undesired effects are caused by buffer management actions within a flow controlled system.

The solution to this problem proposed in claim 1 of the present application is considered as involving an inventive step (Article 33(3) PCT) since it allows the buffer management procedure to adapt its actions based on the decisions taken by the flow control procedure.

2. The subject-matter of independent claims 20 and 21 corresponds, in terms of a computer program product and a controller, to the subject-matter of method claim 1.
Therefore claims 20 and 21 also meet the requirements of novelty and inventive step, based on the same reasoning as in 1. above.
3. Claims 2-19 and 22-32 are dependent on claims 1 and 21 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

Re Item VIII. Clarity issue

The definition of the term "flow control parameter" is not clear from the wording of the claim as such:

A doubt still exist whether the "flow control parameter" is a parameter that could be used for performing flow control, and in this case the Link RTT as defined in document D1 could be used for taking flow control measures concerning the flow passing through said link, or if the "flow control parameter", following the description on page 3 lines 6 to 31, is a **predetermined parameter used by a flow control routine and sent by either the receiver or the sender** (control window, control rate..).

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Claims

- 5 1. A method of controlling a queue buffer (20), said queue buffer (20) being connected to a link (40) and being arranged to queue data units (30) of a flow in a queue (21), comprising
- 10 determining (S1) a value of a length parameter (QL; QL_{av}) related to the length of said queue,
- comparing (S2) said value (QL; QL_{av}) with a length threshold value (L_{th}) and performing (S3) a congestion
- 15 notification procedure if said value (QL; QL_{av}) is greater than said length threshold value (L_{th}), and
- an automatic threshold adaptation procedure (S6),
- 20 characterized in that
- said automatic threshold adaptation procedure (S6) comprises a procedure for adjusting said length threshold value (L_{th}) on the basis of one or more flow
- 25 control parameters (LIM1, LIM2; rwnd; rlfir).
2. The method of claim 1, wherein said one or more flow control parameters (LIM1, LIM2) are predetermined values.
- 30 3. The method of claim 2, wherein said predetermined values are associated with known flow control procedures for one or both of data unit senders and data unit receivers.

35

4. The method of one of claims 1 to 3, furthermore comprising a procedure (S5) for determining one or more of said one or more flow control parameters (LIM1, LIM2; rwnd; rlfir) from a flow control parameter (rwnd; rlfir) introduced by one of a sender and a receiver of said flow queued in said queue (21).
5. The method of claim 4, wherein said flow control parameter is introduced by said receiver and inserted into acknowledgment data units sent from said receiver to said sender for acknowledging the correct receipt of data units.
6. The method of claim 5, and said buffer being provided in a network node of a communication network connecting said sender and said receiver, wherein said procedure for determining said flow control parameter comprises extracting said flow control parameter from said acknowledgement data units at said network node.
7. The method of claim 5 or 6, and said buffer being provided in a first network node of a communication network connecting said sender and said receiver, wherein said procedure for determining said flow control parameter comprises extracting said flow control parameter from said acknowledgement data units at a second network node different from said first network node and sending said flow control parameter from said second network node to said first network node.
8. The method of one of claims 1 to 7, and a flow control performed for said flow in said queue (21) being window-based, wherein one of said one or more flow control parameters is a control window.

9. The method of claim 8, wherein said control window is introduced by said receiver and expresses a limitation of how many data units the receiver can handle.
- 5 10. The method of claim 8, wherein said control window is introduced by said sender and expresses a limitation of how many data units the sender can send.
- 10 11. The method of one of claims 1 to 7, and a flow control performed for said flow in said queue (21) being rate-based, wherein one of said one or more flow control parameters is a control rate.
- 15 12. The method of claim 11, wherein said control rate is introduced by said receiver and expresses a data rate limitation for arriving data units that the receiver can handle.
- 20 13. The method of claim 11, wherein said control rate is introduced by said sender and expresses one of a data rate limitation for the rate of data units that the sender can send, a current sending rate and a target sending rate.
- 25 14. The method of one of claims 1 to 13, wherein said automatic threshold adaptation procedure comprises
- 30 estimating a link capacity value (LC),
- analyzing whether the performance of a congestion notification procedure will lead to an underutilization of said link due to a reaction of said sender to the congestion notification under the condition that said
- 35 length threshold value (L_{th}) is set equal to said estimated link capacity value (LC), and

adapting said length threshold value (L_{th}) on the basis of a result of said analyzing step by setting said length threshold value (L_{th}) equal to said estimated link capacity value (LC) if said analyzing step indicates no underutilization, and setting said length threshold value (L_{th}) larger than said estimated link capacity value (LC) otherwise.

15. The method of claim 14, wherein said length threshold value (L_{th}) is set to a value derived on the basis of one of said flow control parameters (LIM1, LIM2; rwnd; rlfir) if said analyzing step indicates underutilization.

16. The method of claim 14 or 15, and a sender of said flow in said queue (21) sending said data units in a predetermined sequence, a receiver of said flow in said queue (21) sending to said sender acknowledgment messages for acknowledging the correct receipt of said data units, where each acknowledgment message identifies the last data unit correctly received in said sequence, and said receiver sending to said sender a first window value expressing a limitation of how many data units the receiver can handle, a flow control performed by said sender being window-based using a send window, said send window being selected as the minimum of said first window value and a second window value, such that said sender must not send data units with a sequence number higher than the sum of the highest acknowledged sequence number and the send window, and said sender dividing said second window value by two as a reaction to a congestion notification, and thereafter increasing the second window by a predetermined increment for each duplicate acknowledgment message it receives,

wherein

one of said one or more flow control parameters (LIM1, LIM2; rwnd; rlfr) is said first window value and said length threshold value (L_{th}) is initially set equal to said estimated link capacity value (LC), and

said automatic threshold adaptation procedure comprises setting said length threshold value (L_{th}) equal to said estimated link capacity value (LC) if said first window value is greater than 1.5 times the sum of said estimated link capacity value (LC) and the momentary value of said length threshold value (L_{th}).

17. The method of claim 16, wherein said automatic threshold adaptation procedure comprises setting said length threshold value (L_{th}) equal to said estimated link capacity value (LC) if said first window value is greater or equal to 1.5 times the sum of said estimated link capacity value (LC) and the momentary value of said length threshold value (L_{th}).

18. The method of claim 16 or 17, wherein said length threshold value (L_{th}) is set equal to a function of said first window value if said first window value does not fulfil the condition for setting said length threshold value (L_{th}) equal to said estimated link capacity value (LC).

19. The method of claim 18, wherein said function is the difference between said first window value and a predetermined reduction value.

20. A computer program product comprising a computer program arranged to execute the method of one of claims 1 to 19 when executed on a programmable data processing device connected to a communication network containing said link.

21. A queue buffer controller (10) for controlling a queue buffer (20) that is connected to a link (40) and is arranged to queue data units (30) of a flow in a queue (21), comprising

5 a queue length determinator (101) for determining a value of a length parameter (QL; QL_{av}) related to the length of said queue,

10 a comparator (102) for comparing said value with a length threshold value,

15 a congestion notifier (103) for performing a congestion notification procedure if said value is greater than said length threshold value, and

a threshold adaptor (104) for automatically adapting said length threshold value,

20 characterized in that

25 said threshold adaptor (104) being arranged for adjusting said length threshold value on the basis of one or more flow control parameters (LIM1, LIM2; rwnd; rlfir).

22. The queue buffer controller (10) of claim 21, wherein said one or more flow control parameters (LIM1, LIM2) are predetermined values.

30 23. The queue buffer controller (10) of claim 22, wherein said predetermined values are stored in said queue buffer controller (10) and associated with known flow control procedures for data unit receivers.

35 24. The queue buffer controller (10) of one of claims 21 to 23, further comprising a flow control parameter

determinator (105) for determining one or more of said one or more flow control parameters (LIM1, LIM2; rwnd; rlfr) from a flow control parameter (rwnd; rlfr) introduced by one of a sender and a receiver of said flow queued in said queue (21).

25. The queue buffer controller (10) of claim 24, wherein said flow control parameter is introduced by said receiver and inserted into acknowledgment data units sent from said receiver to said sender for acknowledging the correct receipt of data units, and said queue buffer (20) being provided in a network node of a communication network (3) connecting said sender and said receiver, wherein said flow control parameter determinator (105) is arranged for extracting said flow control parameter from said acknowledgement data units at said network node.

26. The queue buffer controller (10) of claim 24, wherein said flow control parameter is introduced by said receiver and inserted into acknowledgment data units sent from said receiver to said sender for acknowledging the correct receipt of data units, and wherein said queue buffer (20) is provided in a first network node of a communication network (3) connecting said sender and said receiver, wherein said flow control parameter determinator (105) is arranged for receiving said flow control parameter from a second network node at which said flow control parameter was extracted.

27. The queue buffer controller (10) of one of claims 21 to 26, wherein said threshold adaptor (104) comprises an estimator for estimating a link capacity value (LC), an analyzer for analyzing whether the performance of a congestion notification procedure will lead to an

underutilization of said link due to a reaction of said sender to the congestion notification under the condition that said length threshold value is set equal to said estimated link capacity value (LC), and

5 an adaptor for adapting said length threshold value on the basis of a result of said analyzing step by setting said length threshold value equal to said estimated link capacity value (LC) if said analyzing step indicates no
10 underutilization, and setting said length threshold value larger than said estimated link capacity value (LC) otherwise.

15 28. The queue buffer controller (10) of claim 27; wherein said threshold adaptor (104) is arranged to set said length threshold value to a value derived on the basis of one of said flow control parameters (LIM1, LIM2; rwnd; rlfr) if said analyzer indicates underutilization.

20 29. The queue buffer controller (10) of claim 27 or 28, a sender of said flow in said queue sending said data units in a predetermined sequence, a receiver of said flow in said queue sending to said sender acknowledgment messages for acknowledging the correct receipt of said
25 data units, where each acknowledgment message identifies the last data unit correctly received in said sequence, and said receiver sending to said sender a first window value expressing a limitation of how many data units the receiver can handle, a flow control performed by said
30 sender being window-based using a send window, said send window being selected as the minimum of said first window value and a second window value, such that said sender must not send data units with a sequence number higher than the sum of the highest acknowledged sequence
35 number and the send window, and said sender dividing said second window value by two as a reaction to a congestion notification, and thereafter increasing the

second window by a predetermined increment for each duplicate acknowledgment message it receives,

wherein

one of said one or more flow control parameters (LIM1, LIM2; rwnd; rlfir) is said first window value and said threshold adaptor (104) is arranged to initially set said length threshold value equal to said estimated link capacity value, and to set said length threshold value equal to said estimated link capacity value if said first window value is greater than 1.5 times the sum of said estimated link capacity value (LC) and the momentary value of said length threshold value (Lth).

30. The queue buffer controller (10) of claim 29, wherein said threshold adaptor (104) is arranged for setting said length threshold value equal to said estimated link capacity value if said first window value is greater or equal to 1.5 times the sum of said estimated link capacity value (LC) and the momentary value of said length threshold value (Lth).

31. The queue buffer controller (10) of claim 29 or 30, wherein said threshold adaptor (104) is arranged to set said length threshold value equal to a function of said first window value if said first window value does not fulfil the condition for setting said length threshold value equal to said estimated link capacity value.

32. The queue buffer controller (10) of claim 31, wherein said function is the difference between said first window value and a predetermined reduction value.